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Effect of livestock grazing and human uses on herbaceous species diversity in oriental beech (*Fagus orientalis* Lipsky) forests, Guilan, Masal, northern Iran

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Abstract : Plant diversity plays key ecological roles in forest ecosystems, including influencing succession, resilience and nutrient cycling. This study was conducted to investigate the effect of livestock grazing and human uses on herbaceous species diversity. We surveyed 50 ha of protected area and 50 ha of unprotected area to evaluate herbaceous species diversity in oriental beech (*Fagus orientalis* Lipsky) forests in northern Iran. We calculated and compared three indices each of diversity and evenness, and species richness between the two areas. Herbaceous cover was higher in the unprotected area while leaf litter depth and tree canopy cover were higher in the protected area. The diversity indices, H (Shannon-Wiener index), N_1 (McArthur index), N_2 (Hill′s index), E_Q (Modified Nee index), E_{var} (Smith-Wilson index), E_5 (modified index of Hill) and R=S (species richness) and species richness R=S were greater in the protected area than in the unprotected area, suggesting that protection from grazing results in increased numbers of plants and species. The effect of land protection on plant diversity was more pronounced for evenness than for species richness and the positive correlation between diversity and evenness indices was higher than that between diversity and richness.

Keywords: grazing, human uses, richness, evenness, beech forests, Cas-

pian forest

Introduction

Plant diversity plays key ecological roles in forest ecosystems, influencing succession, resilience and nutrient cycling (Nilsson and Wardle 2005; Gilliam 2007; Hart and Chen 2008). Therefore, vegetation studies are important to assess the current state of forest ecosystems and to make projections for the near future. In the last few decades, especially after the Rio de Janeiro conference on global biodiversity, loss of biodiversity caused by human activities became a major source of concern for forest ecologists (UNCED 1992). Such disturbances can profoundly alter plant communities in terms of density and composition. Pressures on ecosystems, including grazing and human utilization, cause degradation and reduce genetic diversity, especially in forests, which are considered one of the most sensitive ecosystems. Direct effects of grazing and trampling on species diversity depend on abiotic factors such as weather conditions and soil characteristics that can significantly affect the structure, canopy and soil properties of forests along with air temperature and humidity. Ultimately, depending on biotic and abiotic factors associated with environmental conditions and grazing, the functions of entire ecosystems can change (Sætersdal et al. 2004; Cingolani 2005).

Many studies of vegetation response concluded that high grazing intensity reduced plant diversity by decreasing evenness in plant communities (Tillman and Downing 1994). Conversely, other studies indicated that low grazing intensity positively affected ecosystem functions and vegetation diversity depending on the type and abundance of livestock as well as grazing period and vegetation type (Bouahim et al. 2011; Frank and McNaughton 1993; Augustine and Frank 2001; Casasus et al. 2007; Loucougaray et al. 2004; Van Uytvanck and Hoffmann 2009).

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Forests cover 12 million hectares of the land surface of Iran (8% of the total land area), of which about 1.8 million hectares are located in the northern part of the country, i.e. the Hyrcanian or Caspian Forest ecoregion. This forest type is situated on the northern slopes of the Alborz Mountains along the Caspian Sea (Sagheb-Talebi et al. 2004). Some parts of this forest are under pressure from grazing and human utilization. Among the forest communities in northern Iran, plant communities dominated by oriental beech (*Fagus orientalis* Lipsky) are more valuable for society because they constitute a major sink of carbon (Hall et al. 2001) and are important for socio-economic activities, soil protection and recreation resources (Wardle 2005).

Forests dominated by oriental beech cover about 565,000 ha and represent the total area of indigenous forests in Guilan Province. Considering the socio-economic importance of these ecosystems and their conservation, the general objective of this study was to investigate the effects of grazing and human activities on herbaceous species diversity of these forests. The results can contribute to development and application of sustainable management in the forests of this region within which plant diversity has never been studied.

Material and methods

Study areas

This study was carried out in a 100-ha forest area of the Masal of Guilan province in northern Iran at latitude 37°14'00" to 37°19'20" N and longitude 48°55'19" to 49°02'00" E. Elevation ranges from 300 to 2000 m, a.s.l. and the area is mainly characterized by east-facing slopes. Mean annual precipitations and temperature are 990 mm and 16°C, respectively (information from station of Hydrology and Meteorology at Shanderman). Common forest soils are acidic with pH of 5.5 to 6.5. Parent materials include shill, sandstone and limestone.

There was no permanent residential land in the study area, but dairy farmers and locals generally used the area for animal husbandry for about 2-4 months during spring and summer each year. The forests were under heavy pressure of livestock grazing, girdling, and excessive cutting of trees and shrubs to supply fuel wood. All these activities were thought to change the primary structure of these forests that are uneven-aged and composed of mixed deciduous broadleaved trees or, more rarely, of oriental beech only. The protected area was dominated by oriental beech which was less abundant in the unprotected area due to destructive activities such that a significant proportion of the area completely lacked trees. To restore forests and reduce grazing pressure, 50 ha of these forests were fenced in 2005 to prevent the entry of livestock and humans.

Data collection

We surveyed 50 ha of protected area and 50 ha of unprotected area. Survey sites were selected along the sides of a road near each other. The protected and unprotected areas were similar in

terms of elevation, slope and aspect. At each survey area, 25 circular plots of 1000-m^2 area were established following a random-systematic network using a 100 m × 200 m grid (Zobeiry 2002). Elevation, aspect and slope gradient were recorded at each sampling point. In addition, we measured litter depth at five locations within each plot (Adel et al. 2013) and we estimated the number of trees per hectare and the percent canopy cover of trees. Because the 1000 m^2 plots were too large for detailed measurements of herbaceous species, we used the Whittaker's nested plot sampling and minimal area method to determine an optimal subplot size. This resulted in subplots of 64 m^2 being sampled for herbaceous species measurements and in each of these subplots, percent cover of each species was estimated according to the Domin criterion (Mueller and Ellenberg 1989).

Data analysis

To evaluate herbaceous diversity, we computed different components of diversity, evenness and richness. First, species diversity was assessed with the Shannon-Wiener (H') and McArthur and Hill's indices (Ludwig et al. 1988; Krebs 1999).

Shannon-Wiener index:

$$H' = \sum_{i=1}^{n} p_i \ln p_i \qquad (1)$$

where, P_i is the relative frequency of the ith species

McArthur index:

$$N_1 = e^H \qquad (2)$$

where, N_1 is an equal number of common species that create diversity similar to the H'. The e is logarithm, H' is Shanon-Wiener.

Hill's index:

$$N_2 = \frac{1}{\lambda} \qquad (3)$$

where, λ is the dominance index of Simpson and N_2 is the inverse of Simpson's dominance index.

Second species richness was estimated (Humphries et al. 1996) according to the R=S index in which S is the number of species. Finally evenness was assessed using the Smith-Wilson index, the modified index of Nee (E_Q) and the modified index of Hill (E_5) (Krebs 1999):

Smith-Wilson index:

$$E_{var} = \cfrac{2}{\pi \arctan\left\{ \sum_{i=1}^{s}\left[\log_e(n_i) - \sum_{j=1}^{s} \log_e(n_j)/s \right]^2 /s \right\}} \quad (4)$$

where, n_i is the number of individuals of the ith species in a plot, n_j is number of individuals of the jth species, and S is the total number of species;

Modified index of Hill:

$$E_5 = \frac{N_2 - 1}{N_1 - 1} \quad (5)$$

where, N_1 is an equal number of common species that yield diversity similar to that expressed by H', N_2 is the inverse of Simpson's dominance;

Modified Nee index:

$$E_Q = \frac{2\arctan(b)}{\pi} \quad (6)$$

where, b is the gradient of Dominance - Diversity curves. All diversity indices were computed with Ecological Methodology software for Windows, version 6.0 (Krebs 1989). Kolmogorov–Smirnov tests were used to study the normality of data distribution. To detect differences in diversity indices between protected and unprotected areas, Student t-tests were used in the case of normally distributed data while the non-parametric equivalent (Mann-Whitney U-test) was applied to other cases. These analyses were conducted with SPSS 16.0 software.

Results

Mean leaf litter depth and mean percent canopy cover of trees in the protected area were both significantly higher than in the unprotected area. Mean percent herbaceous cover was higher in the unprotected area than in the protected area (Table 1). In the combined areas, we recorded 64 species of 35 plant families, with 51 species of 33 families in the protected area and 49 species of 31 families in the unprotected area (Appendix 1).

Table 1: Characteristics of the protected and unprotected study area.

Characteristics	Area (ha)	*Fagus orientalis*, tree (ha)	*Fagus orientalis*, DBH (cm)	Sum of basal area (m²)	Slope (%)	Elevation (m)	Herbaceous cover (%)	Leaf litter depth (cm)	Canopy cover (%)
Protected	56	272	59.92	77.003	66.36	1208.4	91.56	9.6	70.32
Unprotected	57	76	44.80	46.38	67.08	1136.6	99.01	1.4	25.28
P	-	0.000**	0.08	0.000**	-	-	0.5	0.000**	0.000**

Notes: **Indicate a significant differences at the 99% level between protected and unprotected areas.

Although many species were common to both areas, some were only present in the protected area (*Hordeum* spp*., Hordeum spontaneum, Sanicula europaeaI, Alium* spp*., Malva* spp.*, Hypericum perforatum, Lathyrus* spp*., Orobus* spp.*, Solanum nigrum, Convulva* L, *Nasturtium officinal*) while others were only present in the unprotected area (*Crocus sativus, Conyza canadensis, Tanacetum* spp*., Crisium avvense, Cricium congestum, Taraxacum* sp, *Gundeliatour enfortti, Acropetilon repens, Asperula stylosa, Bromus* L, *Teucrium hyrcanicum, Cephalanthera sp*).

In the protected area, the Poaceae family was represented by the highest number of species (5) while Asplenaceae and Lamiaceae were represented by four species each. Hypericaceae, Polygonaceae, Asteraceae, Solanaceae, Rosaceae, Brassicaceae, Apiaceae each had two species and other families' one species. In the unprotected area, the family with most species was Asteracea at seven species while Poaceae was represented by five species, Asplenaceae by four species, Rosaceae by three species, and Lamiaceae, Solanaceae, Polygonacea, and Apiaceae by two species each. In the protected area, the highest species frequencies were associated with *Euphorbia amygdaloides* (100), *Pteridium aquilinum* (80), *Ceterach officinarum* (80), *Primula hetrochroma* (72), *Fragaria vesca* L. (72), and *Rumex* sp (60). In the unprotected area, highest frequencies were *Viola sylvestris* (92), *Prunella vulgaris* (84), *Petasites hybrids* (76), *Rubus fruticosus* (76), *Potentilla recta* (72), *Sambacus ebulus* (64), *Sedum stoloiferum* (60), and *Rumex* spp.. Six species in the protected area and one species in the unprotected area occurred at frequencies less than five.

In the protected area, highest percent cover was recorded for *Euphorbia amygdalodies* (17.7%), *Lathyrus* spp. (12%), *Lamium alb*a (11%), *Circaea lutetiana* L (10%), *Primula hetrochrom* (9.2%), and *Phytolacca American* (7.2%). In the unprotected area, highest percent cover was recorded for (Table 2): *Sambacus ebulus* (39.1%), *Pteridium aquilinum* (33.2%), *Chenopodium album* (13.7%), *Prunella vulgaris* (12.3%), *Asplenium trichomanes* (9.2%), *Potentilla recta* (8.3%) and *Teucrium hyrcanicum* (8.3%).

One species in the protected area and 15 species in the unprotected area accounted for less than 1% of herbaceous cover. Percent cover of 15 species differed significantly between the areas. With the exception of *Pteridium aquilinum, Asplenium trichomanes, Sedum stoloniferum* and *Rumex* spp., percent cover of the above-listed species was higher in the protected than in the un-

protected area. Values of diversity indices H', N_1, N_2 a_{Var} and E_5 were greater in the protected area than in the unprotected area, and all differences except for the E_{Var} index were significant at the 5% level. Richness was higher in the protected area than in the unprotected area, but the difference was not significant (Table 2).

Table 2: Means, Standard deviation (SD) and Standard Error (SE) of biodiversity indices in protected and unprotected areas.

Index		Protected			Unprotected			
		Mean	SD	SE	Mean	SD	SE	P
Diversity	H'	3.25	±0.47	±0.94	2.82	±0.46	±0.93	0.003**
	N_1	9.95	±2.68	±0.53	7.39	±2.44	±0.48	0.001**
	N_2	7.73	±2.54	±0.50	5.20	±1.94	±0.38	0.000**
Evenness	E_{Var}	0.51	±0.131	±0.26	0.45	±0.158	±0.31	0.1
	E_Q	0.17	±0.033	±0.006	0.15	±0.380	±0.007	0.02*
	E_5	0.73	±0.133	±0.26	0.64	±0.133	±0.26	0.03*
Richness	R=S	15.7	±3.21	±0.64	15.1	±3.59	±0.71	0.5

Notes: * indicate a significant differences at the 95% and **Indicate a significant differences at the 99% level between protected and unprotected areas.

Pearson correlations between diversity indices and both evenness and richness indices are presented in Table 3. In the protected area, E_5 index was positively and significantly (0.01%) correlated with H', N_1 and N_2 indices whereas E_{Var} and Nee indices had significant correlations with N_2 index (at 5% level). Also, E_{Var} index was significantly (5%) correlated with N_1 index while R=S index was significantly related to H' and N_1 indices at the 5% level (Table 3). In the unprotected area, E_{Var} was positively correlated with diversity indices whereas $R=S$ index was correlated with H' and N_1 indices, but not with N_2 index. E_5 index was positively and significantly correlated with N_2 index at the 1% (Table 3).

Table 3: Pearson correlations between diversity indices with richness and evenness.

Index	Protected			Unprotected		
	H'	N_1	N_2	H	N_1	N_2
E_Q	0.38	0.372	0.451*	0.22	0.21	0.35
E_5	0.708**	0.633**	0.844**	0.58	0.05	0.423*
E_{var}	0.38	0.426*	0.45*	0.518**	0.505**	0.539**
R=S	0.403*	0.47*	0.24	0.62*	0.45*	0.35

Notes: H' (Shannon-Wiener index), N_1 (McArthur index), N_2 (Hill's index), E_Q (Modified Nee index), E_{var} (Smith-Wilson index), E_5 (modified index of Hill) and R=S (species richness). * Indicates that correlation was significant at the 0.05 level. ** Indicate that correlation was significant at the 0.01 level.

Discussion

Diversity, richness and evenness were lower in areas that were subject to intensive human exploitation and livestock grazing. Many other studies have shown that the number and diversity of forest herbaceous species are sharply reduced by similar destructive factors such that many sensitive species have been eradicated (Keeley et al. 2003; Bouahim et al. 2011; Krzic et al. 2003; Hendricks et al. 2005; Milgo 2006; Cesa et al. 2011). Conversely, when forests receive protection from grazing, plant and species numbers increase markedly (Bertoncini and Rodrigues 2008; Bengtsson et al. 2002; Schmidt 2005; Caspersen and Pacala 2001).

Species richness was slightly higher in the protected than in the unprotected areas and this could be predicted because grazing is known to be a cause of reduced species richness (Roberts and Zhu 2002; Schumann et al. 2003; Pykälä 2005; Shackleton et al. 2000; Altesor et al. 2006; Loydi and Distel 2010; Schultz et al. 2011). In both areas, diversity was more strongly correlated with evenness than richness. This result is supported by observations of the important role of evenness in increasing diversity as compared to species richness (Casado et al. 2004; Anderson et al. 2007; Arévalo et al. 2007; Fernandez-Lugo et al. 2009). In the unprotected area, grazing reduced both evenness and species diversity by removing and reducing the coverage of some sensitive species (Webster et al. 2005; Milgo 2006). Therefore, species diversity was maximum when grazing pressure was minimum, as reported for other ecosystems (Jouri 2009; Nikbole and Ojima 2004; Yingzhang et al. 2004; Ta´rrega et al. 2006).

Average litter depths were 9.6 and 1.4 cm in the protected and unprotected areas, respectively. Accordingly, higher values of litter depth and percent cover of herbaceous species were reported for protected areas in other studies (Potvin and Harrison 1994; Berg et al. 1997). In our protected area, the high density of herbaceous species was an important factor explaining greater litter depth and the high density of deciduous trees. The absence of grazing accounted for the greater litter depth in the protected area. In contrast, in the unprotected area, grazing was an important factor reducing litter depth and vegetation cover (Xie et al. 2007; McEvoy et al. 2006). The destruction and the excessive use of herbaceous cover probably reduced the growth and the reproduction capacity of many species while some sensitive species probably disappeared over time and were replaced by invader species as reported for other sites by Onainadia et al. (2004) and Webster et al. (2005). Reduced litter depth can also be attributed to the mechanical effects of trampling and grazing that stimulate litter decomposition by crushing litter into small pieces. Together with changes in forest density and composition, reduction in litter depth caused by grazing negatively impacted forest

ecosystems through changes in organic matter that promote soil erosion (Belsky and Blumenthal 1997).

Grazing has a negative effect on threatened species (Campbell and Donlan 2005; Carrete et al. 2009). *Lathyrus sylvatica* was a common and dominant species in the protected area, but its abundance was sharply reduced when subject to grazing (Mitchell and Kirby 1990). Also, *Hedra helix and Primula hetrochroma* are palatable species for livestock, but are resistant to grazing and are indicator species for protected areas (Kuiters and Slim 2003; Kirby 2001).

Some species were only recorded in the unprotected area (Table 2), suggesting that grazing could have promoted colonization by a number of rare species or unpalatable species for livestock. Actually, these species successively competed with other species and their growth was completed before livestock entered the area. Grazing can cause changes in the pattern of species dominance (Muthuramkumar et al. 2006; Aikens et al. 2007; Rasingam et al. 2009). For example, the dominant Asteraceae family in the unprotected area was replaced in the unprotected area by *Cricium congestum, Crisium avvense, Uritica dioica, Prunella vulgaris* or *Rumex* sp, which can be considered as indicator species of the unprotected area. On the other hand, *Euphorbia amygdaloides* can be considered as an indicator species of the protected area (McEvay et al. 2006).

Percent cover of herbaceous species reached 91.6 and 99.0% in the protected and the unprotected areas, respectively, while tree canopy cover was lower in the unprotected than the protected area. On forest sites, herbaceous species richness is mostly influenced by canopy openness which increases with site degradation. The reduction of canopy cover increases solar irradiation at the forest floor and, by providing the energy-rich material for photosynthesis, increases plant production (Ebrahimzade 1990; Boer, 1998). Decomposition, on the other, increases temperature and moisture, both key factors for controlling litter decomposition (Lousier and Parkinson 1975; Moore 1986), and thereby stimulates (Riterr 2005; Hopmans 2006) and ultimately leads to increased availability of nutrients. This could explain the higher herbaceous cover in the unprotected area. However, disturbances such as grazing and human pressure can lead to changes in ecological conditions, especially competition among plant species and can alter vegetation composition and promote the emergence of invasive species (Keeley et al. 2003; Anderson 2007; Vera et al. 2000).

Invasive species, characterized by rapid seed dispersal and germination, high competitive capacity, short life span and fast growth, strongly compete with native species and have caused changes in the structure and processes of many ecosystems (Godefroid et al. 2005; Martin et al. 2009). Establishment of invasive species in natural ecosystems is usually slow, but this process is accelerated by human intervention and site degradation (Martin et al. 2009).

In the unprotected area, the dominance of *Pteridium aquilinum* and *Sambucus ebulus* increased gradually such that in many locations, their coverage was 100% to form a closed cover above the ground. These species were mainly present in gaps resulting from human activities. On the other hand, due to the tall height

of invasive species, competition for light increases and thus richness and percent cover decline for many forest floor species (Howard and Lee 2003). In addition, *Sambucus ebulus* can reduce growth of other species by allelopathy and chemical release (Pourbabaei et al. 2004). Of species in the unprotected area, none exceeded 5% in cover except *Potentila recta, Viola sylvestris, Asplenium trichomanes, Polygonatum orientale, Prunella vulgaris, Acropetilon repens, Teucrium hyrcanicum*.

The percent cover of 15 plant species differed between the protected and the unprotected areas. For example, the percent cover of typical species of beech communities in northern Iran such as *Euphorbia amygdaloides, Lamium album* L, *Viola sylvestris, Carex* sp, *Sanicula europaeal, Chenopodium album* L. and *Galium* sp (Taheri and Pilevar 2008) was lower in the unprotected than in the protected areas, suggesting that they were negatively affected by grazing and human activities. Since species diversity and richness are closely associated with grazing and traditional human activities, conservation programs should be developed in collaboration with local people in order to promote education and correct land utilization to help conserve natural resources and biodiversity. In addition, we recommend controlling livestock access and exploitation by local people in sensitive forest areas. Finally, studies should be undertaken to determine the parameters of conservation and restoration of these ecosystems.

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Appendix 1: Frequency and mean percent cover of herbaceous species in protected and unprotected areas.

Species	Family	Mean percent cover (%)		Frequency		P
		Protected	Unprotected	Protected	Unprotected	
Vincetoxicum scandens	Asclepiadaceae	4.1	3	40	8	0.8
Phytolacca americana	Phytolaccaceae	7.23	1	17	52	0.001**
Primula hetrochroma	Primulaceae	9.2	3.21	72	56	0.001**
Fragaria vesca L.	Rosaceae	4.38	3.4	72	48	0.1
Euphorbia amygdaloides	Euphorbiaceae	17.68	3	100	56	0.000**
Daucus spp.	Apiaceae	5	1	4	8	0.1
Pteridium aquilinum	Hypolepidaceae	6.45	33.16	80	60	0.002**
Asplenium adianthum nigra	Aspleniaceae	2.6	1	48	24	0.03*
Lamium album L.	Lomiaceae	10	1	4	8	0.04*
Tamus communis	Discoraceae	3.25	3.75	48	16	0.8
Asplenium trichomanes	Aspleniaceae	2.16	9.6	24	12	0.04*
Sedum stoloniferum	Crassolaceae	3.43	4.26	64	60	0.9
Granium robertianum	Geraniaceae	5.7	1	40	20	0.000**
Lapsana communis L.	Asteraceae	6.5	1	16	16	0.04*
Carex spp.	Cyperaceae	4	1	16	8	0.4
Viola sylvestris	Violaceae	7.06	5.39	64	92	0.02*
Ceterach officinarum	Aspleniaceae	6.05	2.3	80	52	0.01*

Continued Appendix 1:

Species	Family	Mean percent cover (%)		Frequency		P
		Protected	Unprotected	Protected	Unprotected	
Salvia glutinosa	Lomiaceae	3.72	2.33	44	12	0.8
Conyza canadensis	Asteraceae	3.4	1	40	12	0.2
Polygonum hydropiper	Polygonaceae	3	-	4	-	-
Hordeum sp.	Poaceae	1	-	12	-	-
Phyllitiss chlopendrium	Aspleniaceae	7.25	2	16	8	0.4
Hypericum androsaemum	Hypericaceae	8.21	1.5	24	24	0.001**
Rumex sp.	Polygonaceae	3.46	15	60	4	0.04*
Polygonatum orientale	Asparagaceae	2.5	5.5	8	8	0.6
Oplismenus undulatifolius	Poaceae	1.33	3.33	36	12	0.3
Hordeum spontaneum	Poaceae	2.04	-	20	-	-
Cardamine sp.	Brassicaceae	3	-	24	-	-
Sanicula europaeal	Apiaceae	3.8	-	40	-	-
Prunella vulgaris	Lomiaceae	5	12.33	12	84	0.2
Sambucus ebulus	Caprifoliaceae	5.1	39.125	40	64	0.01*
Alium sp.	Amaryllidaceae	2.16	-	24	-	-
Urtica dioica	Urticaceae	4.5	4.92	8	52	0.3
Calystegia silvesteris	Convolvulacoae	1.5	-	20	-	-
Malva sp.	Malvaceae	2.33	-	12	-	-
Dactylis glornerata	Poaceae	2.25	3.71	8	16	0.8
Galium sp.	Rubiaceae	7.4	1	20	2	0.01*
Trifolium resupinatum	Fabaceae	4.25	2.33	48	12	0.5
Oxalis sp.	Oxalidaceae	4	2.5	8	8	0.08
Potentila recta	Rosaceae	5.5	-	8	-	-
Hypericum perforatum	Hypericaceae	4	-	4	-	-
Campanula odontosepala	Companulaceae	8	2.6	4	12	0.3
Circaea lutetiana L.	Onageraceae	11	2.5	8	8	0.1
Lathyrus sp.	Fabaceae	12	-	4	-	-
Orobus sp.	Fabaceae	4.75	-	16	-	-
Solanum nigrum	Solanaceae	1.33	3.4	12	20	0.7
Hedra helix	Araliaceae	3	-	4	-	-
Nasturtium officinale	Brassicaceae	5.5	-	8	-	-
Petasites hybridus	Asteraceae	4	-	4	-	-
Atropa beladona	Solanaceae	4.3	1.75	24	16	0.7
Microstigum sp	Poaceae	6.5	2.16	16	24	0.1
Crocus sativus	Iridaceae	-	2.33	-	12	-
Tanacetum sp.	Asteraceae	-	1	-	16	-
Crisium avvense	Asteraceae	-	1	-	20	-
Cricium congestum	Poaceae	-	1	-	12	-
Taraxacum sp.	Asteraceae	-	5.2	-	20	-
Gundeliatour enfortii	Asteraceae	-	3.6	-	20	-
Acropetilon repens	Asteraceae	-	5.66	-	12	-
Asperula stylosa	Rubiaceae	-	1	-	8	-
Teucrium hyrcanicum	Lomiaceae	-	8.25	-	16	-
Chenopodium album L.	Chenopodiaceae	-	13.66	-	12	-
Rubus fruticosus	Rosaceae	-	1	-	76	-
Cephalanthera sp.	Orchidaceae	-	2	-	8	-
Bromus L.	Poaceae	-	1	-	8	-

Notes: * indicates a significant differences at the 95% and **Indicate a significant differences at the 99% level between protected and unprotected areas.